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RECOGNIZING AND CONTROLLING PLANT PESTS. HORTICULTURE-SERVICE OCCUPATIONS, MODULE NO. 6.

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ONE OF A SERIES DESIGNED TO PREPARE HIGH SCHOOL STUDENTS FOR HORTICULTURAL SERVICE OCCUPATIONS, THIS MODULE HAS AS ITS MAJOR OBJECTIVE TO DEVELOP THE ABILITIES NECESSARY FOR THE EFFECTIVE CONTROL OF PLANT PESTS. IT WAS DEVELOPED ON THE BASIS OF DATA FROM STATE STUDIES BY A NATIONAL TASK FORCE. SUBJECT MATTER AREAS ARE NEED FOR PLANT PEST CONTROL, PLANT PEST SYMPTOMS IN HORTICULTURAL PLANTS, PLANT PEST IDENTIFICATION, AND PEST CONTROL MEASURES. SUGGESTIONS ARE INCLUDED FOR INTRODUCTION OF THE MODULE, SPECIFIC UNIT OBJECTIVES, SUBJECT MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS AND REFERENCES, AND EVALUATIVE CRITERIA. THE MODULE IS SCHEDULED FOR 14 HOURS OF CLASS INSTRUCTION, 41 HOURS OF LABORATORY AND 100 HOURS OF OCCUPATIONAL EXPERIENCE. TEACHERS WITH A BACKGROUND IN HORTICULTURE MAY USE IT TO PLAN A UNIT FOR LESS ABLE HIGH SCHOOL STUDENTS WHO HAVE AN OCCUPATIONAL GOAL IN ORNAMENTAL HORTICULTURE. THIS DOCUMENT IS AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 619 - 000 631) FOR $7.25 FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212. (JM)

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RECOGNIZING & CONTROLLING PLANT PESTS

One of Twelve Modules in the Course Preparing for Entry in
HORTICULTURE - SERVICE OCCUPATIONS

Module No. 6

The Center for Research and Leadership Development

in Vocational and Technical Education

The Ohio State University
980 Kinnear Road
Columbus, Ohio, 43212

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DATE: August 7, 1967

RE: (Author, Title, Publisher, Date) Module No. 6, "Recognizing and Controlling Plant Pests," The Center for Vocational and Technical Education, August, 1965.

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Uses of Material Instructor course planning
Users of Material Teachers

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RECOGNIZING AND CONTROLLING PLANT PESTS

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RECOGNIZING AND CONTROLLING PLANT PESTS

Major Teaching Objective

To develop the abilities necessary for the effective control of plant pests

Suggested Time Allotments

At school		
Class instruction	14	hours
Laboratory experience	41	hours
Total at school	55	hours
Occupational experience	100	hours
Total for module	155	hours

Suggestions for Introducing the Module

For the purpose of this study, "pests" will include all forms of animal and plant life and any abnormal environmental situations which adversely affect horticultural plants.

It is suggested that the teacher approach the study of pests first from the viewpoint of symptoms developed by host plants, since this is the usual initial encounter with plant pests. The second step is accurate identification of the specific agent causing the symptoms. The third and final development should be the initiation of effective control measures.

Plants are living things and are subject to attack by many pests. Some pests, such as the box-elder bug, attack only certain plants. Other kinds of plants in the area would not be affected by that pest. On the other hand, there are pests which are of general occurrence such as the fungus, Fusarium, a species which affects numbers of different plants. Plants may also develop an appearance which would seem to indicate the presence of some pest. If no pest can be seen, the symptoms may be caused by factors of the environment which affect the physiology (i.e., life processes) of the plant. Some causes of physiological plant disorders may be an abnormal soil water supply fluctuation, an excess or deficiency of a chemical fertilizer, or a waterlogged soil.

Students may be asked to list at least three pests with which they have had experience in the past. Some common pests of humans are:

Mosquito (insect)	Sunburn (caused by environment)
Athlete's foot (fungus)	Hives (caused by environment)
Ticks (insect-like animals)	Warts (caused by virus)

Toothache (decay resulting from bacterial action)
Stable fly (insect)
Mice (Mammals)
Poison ivy rash (flowering plant)

Students will most likely list those pests which are readily seen, such as various insects and some rodents. Inquire if anyone has recently had a toothache or a sunburn. How did they know that they had a toothache or sunburn? Encourage the description of symptoms. Often we first become aware of a pest problem by observing symptoms. Discuss additional pests of humal beings, including some of those listed above. Emphasize the importance of being able to recognize symptoms before the problem becomes too severe.

Point out that all symptoms have a cause. Discussion should bring out the following point:

Pests bothering human beings can be plant, animal, or environmental.

Ask students what they do to treat a mosquito bite, sunburn, or toothache. Point out that it would be better to avoid these uncomfortable situations by using such preventive measures as insect repellents, sun tan lotion, and regular dental care, rather than trying to cure the conditions after they develop. Point out that the salve or lotion used on a sunburn would not help a toothache. In fact, the sunburn medication may cause added problems if applied to the tooth. Only certain medicines should be used for specific problems.

Students should be taken on a visit around the school grounds. Ask them to find some evidence of plant pests. How did they know a plant pest problem existed? Have the student who first found the affected plant describe to the other students what it was about the plant that caused him to notice that it was affected. Ask a student to carefully examine the plant to determine what the cause was of the abnormal condition. If the pest is one the teacher knows the control measures for, point out what should be done to control that pest.

Locate other affected plants as time permits and discuss general symptoms, causes, and controls.

Competencies to be Developed

I. To develop an understanding of the need for plant pest control

Teacher Preparation

Subject Matter Content

Plant pest problems are one of the biggest hurdles man has to overcome in successful plant growing. The annual loss due to plant pests in farm crops has been estimated at five billion dollars. Added to this figure can be an estimated 350 million dollars spent on pesticides and related equipment. Scientists have estimated that as much as ninety percent of the food man grows would be destroyed if he did not constantly control pests. These figures do not include losses and costs of pesticides for ornamental plantings.

The overall picture is one of great expense to human beings who must depend upon plants for survival and thus must compete with other forms of life for the use of these plants. Man is an integral part of the balance of nature. This balance is constantly shifting. If man did not continually exert effort to maintain his position, he would drop to a much lower status or even perish.

We usually notice only those pests which cause rather obvious and sudden symptoms on desirable plants. There are, however, numerous pests which do not cause severe damage, but do affect the plants by continually sapping a small amount of vitality from them. Over a period of time this causes a decline in the condition of the plant, which affects its production or ornamental value.

Plant pests specifically affect us in the following ways:

1. They cut down the quantity of plant production.
2. They cut down the quality of plant production.
3. They lower the ornamental value of plants.
4. They increase costs of producing and maintaining plants.

Suggested Teaching-Learning Activities

1. Take a field trip to a cooperative grower or landscaper who will explain the extensiveness of pest damage in

local crops or ornamental plantings. Ask him to show the variety of equipment and supplies needed to keep these pests in check. An alternate method would be to have a grower, landscaper, or garden store operator speak to the class on the same subject.

2. Point out that the annual loss to farm crops due to pests is estimated at five billion dollars. How much is five billion dollars? If five billion one dollar bills were laid end-to-end, they would reach about eighteen times around the earth. Five billion high school students placed shoulder-to-shoulder would extend about fifty-four times around the earth. Use a chart to illustrate these figures.

3. Discuss "balance of nature" and the constant struggle of man with other forms of life to maintain his top position. Illustrate this fight for survival by referring to the neighborhood stray cat population. A tom cat is "Top Cat" only if he continues to fight to keep his position. The minute he does not fight adequately, he is pushed into a lower level. The struggle by man against other forms of life such as insects, is excellently illustrated in the film "Rival World" produced by the Shell Oil Company. It would be appropriate to show this film at this time.

Suggested Instructional Materials and References

Instructional Materials

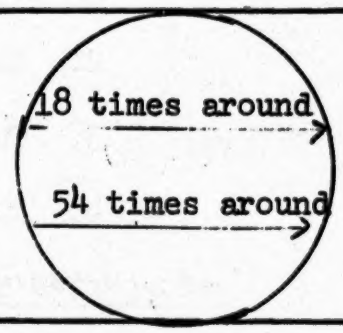
1. Make arrangements for field trips or for competent speakers.

2. Develop a chart showing the figure 5,000,000,000.

Five Billion
$5,000,000,000

5 billion one dollar bills would reach

5 billion high school students would reach



3. "Rival World," film, color. Shell Oil Company.

References

1. Janick, J. Horticultural Science.

2. Agricultural Chemicals, 1963.

T*3. Plant Diseases: The Yearbook of Agriculture, 1953, U. S. D. A.

*The symbol T (teacher) or S (student) denotes those references designed especially for the teacher or for the student.

Suggested time to develop this competency

Classroom teaching	2	hours
School laboratory activity	0	hours
Total time	2	hours

II. To develop the ability to recognize the symptoms of pests affecting horticultural plants

Teacher Preparation

Subject Matter Content

A plant pest can be defined as any living thing, or an environmental condition, which causes a plant grown for a specific purpose to grow abnormally. This abnormal growth condition is commonly called a disease. A fungus, then, is not a disease, but a pest. The abnormal growth of the desired plant resulting from the presence of the fungus is called a disease. Another example would be weeds, which are termed pests. The stunting produced in desired plants due to competition with weeds is a disease. A cow, theoretically, can be termed a plant pest when she chews off part of a plant. The damaged plant can then be described as "diseased."

Plant pest symptoms can be produced by any number of living things or environmental conditions. Since many plant pests (or diseases) are named according to the most obvious symptoms, we can often narrow the identification process by accurately describing the symptoms.

It is suggested that the students begin the study of plant pest symptoms by starting with a known disease or insect on a specific crop, and learning to recognize the symptoms directly associated with this disease or insects as it affects the plant.

The students may be encouraged to recognize other plant pest symptoms by using the following check list:

1. Is any part of the plant broken, damaged, or leaking sap?
2. Is the plant wilting?
3. Is the plant stunted or not developing a normal shape?
4. Is any part of the plant rotted?
5. Is any part of the plant yellowish, brownish, or of a color different than normal?
6. Are there any unusual growths on the plant?
7. Can any pests be seen?

The student list includes all symptoms brought out by a variety of pests. While this list is small, each symptom area is broad. A teacher list has been included to enable the teacher to more critically describe the symptoms as a basis for further pest identification. Students may be exposed to part or all of the teacher's list if circumstances warrant; however, introduction to the study of plant pest symptom identification could probably best be accomplished by using the student list.

Plant damage caused by insects or insect-like creatures often resembles, and can easily be confused with, damage caused by other organisms. The one type of insect-damage easily recognized is where chewing insects eat away parts of the plant. Damage caused by insects which suck plant sap often appears to be caused by some other organism.

After the students have had considerable opportunity to recognize the various plant pest symptoms, the teacher may then continue to relate the symptoms with the causative agent in each case.

Plant Pest Symptoms*

Anthracnose: a blotched or spotted discoloration of leaves, stems, fruit

Blight:	the dying of young tissue, especially leaves and twigs
Blotch:	irregularly-shaped discolored tissue on leaves and stems
Cankers:	dead, cracked-open sections of stems or twigs of woody plants
Chlorosis:	a yellowish or whitish discoloration of a plant
Damping off:	breakdown of the tissue of the stem and root near the soil line
Galls:	swellings or growths on a plant
Gummosis:	the exudation of sap from a plant
Mildew:	grayish white growth on leaves and stems
Mosaic:	a mottling of leaf color
Oedema:	watery swelling of plant parts
Rot:	the decay of plant cells
Rust:	reddish-brown spotting of leaves and stems
Scorch:	the browning and shriveling of leaves
Smut:	the growth of masses of black powdery spores
Spot:	round-shaped discoloration of the foliage and stems
Stunt:	the dwarfing of growth
Wilt:	partial or total drooping of a plant
Witch's Broom:	a tufted growth of small branches usually on woody plants

*For teacher and advanced student use

Suggested Teaching-Learning Activities

1. Present examples of as many plant symptoms (per student list) as available. Have students describe the symptoms,

using their own wording. In most cases, their descriptive terminology will be similar to the symptom list developed for student use. Point out to the students that by now they can describe the symptoms quite well. This may help dispel the fears of some youngsters who expect boring complexity in studying plant pests.

2. Have students prepare mounted specimens or displays of plants showing the various characteristic plant pest symptoms. A caged display, "Plant Pest Symptoms in the Making," using a live, potted plant bearing a chewing insect should provoke interest daily as the insect proceeds to "produce symptoms."

3. Conduct a contest with points awarded for each plant brought in with the symptoms correctly identified. The first student to bring in a plant in each category would be the winner. A fringe benefit for the teacher is the acquisition of quantities of plant materials showing various symptoms.

4. Develop a checklist of symptoms which could be duplicated and given to students to use when identifying plant pest symptoms. Accuracy in description is encouraged. This is vital in later establishing a positive identification of the pest. A sample check list is provided. The statement at the bottom of the sheet above the student's signature is to provide incentive for accuracy. Error in identification and application of later control measures can be costly.

5. Encourage students to bring in samples or pests from plants on their home grounds. This can best be accomplished by allotting a specific day or days for bringing in plants. Symptom identification could be made by members of the class. Specific days for bringing in specimens eliminates the confusion of students bringing in plants daily.

6. Conduct an inspection of plants on the school grounds to locate plants showing pest symptoms. A report could be made to persons in charge of grounds maintenance so that when the class is studying pest control, corrective action might be taken.

7. Pictures of various plant pest symptoms can be obtained from many sources. Judicious use of these pictures with an opaque projector will provide examples of symptoms unavailable on live plants.

8. Conduct an evaluation using selected live symptom-bearing plants.

Suggested Instructional Materials and References

Instructional Materials

1. Plant mounting papers
2. Fine mesh screen cages
3. Check list of plant pest symptoms, for student use (Sample copy is included in this module)
4. Living or mounted plants showing pest symptoms
5. Pictures of plant pest symptoms

References

1. Pirone, Dodge, and Rickett. Diseases of Ornamental Plants. p.p. 3-17.
2. Compendium of Plant Diseases. (Excellent color plates illustrating symptoms)

Suggested time to develop this competency

Classroom teaching	2	hours
School laboratory activity	8	hours
Total time	10	hours

_____ High School

Department of Vocational Horticulture

Plant Pest Detective Work Sheet

Directions: Use this list to help you remember those things which indicate that the plant is unhealthy.

Kind of plant_____ Location_____

Question	Yes or No	Description of Symptom
1. Is any part of the plant broken, damaged or leaking sap?		
2. Is the plant wilted?		
3. Is the plant stunted or not developing a normal shape?		
4. Is any part of the plant rotted?		
5. Is any part of the plant yellowish, brownish, or of a color different from the usual?		
6. Are there any unusual growths on the plant?		
7. Can you spot any pests?		

I have filled in all the plant symptoms I can see.

Name_____

III. To develop the ability to identify specific plant pests as a basis for initiating control measures

Introduction:

In training service workers rather than managers, perhaps instruction should be limited to teaching such skills as operation and routine, care of sprayers and dusters, recognition of simple groupings of symptoms or signs of disease, or insects and the reporting of unusual conditions observed during the course of work to the supervisor. However, there may be students who would profit from additional instruction in identifying plant pests.

This competency area then, may be offered only if the teacher deems it appropriate to his particular group of students.

Teacher Preparation

Subject Matter Content

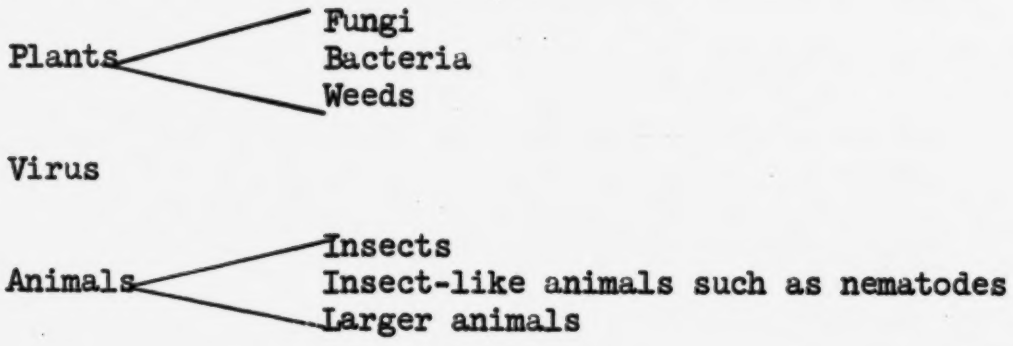
In order to control plant pests, we must be able to identify them to the point where effective control can be initiated. In some cases this identification will have to be exact. In other situations identification need only be made to group certain levels of pests, all of which can be controlled by the same or similar methods.

It is recommended that recourse be made to current reference materials for final, specific, or group identification of pests. This is vital if later student work will include initiating control measures for those pests.

We have previously established with the students that pests of human beings can be either plant, animal, or environmental. The same classificat on can be made with plant pests.

The following illustration can be put on the blackboard to show the basic classification of plant pests.

Kinds of Plant Pests



Fungi are probably the most common pests of plants. A fungus is a plant that lacks the green pigment, chlorophyll, which is found in most plants. This means that the fungi do not make their own food. They obtain food from either dead or living plants. In obtaining food from live plants, fungi often cause damage. Some fungi are microscopic while others may develop reproductive parts up to two feet in diameter.

Fungi that cause plant diseases usually live within the cells of the plants that they affect. They are only visible without the use of a microscope when they develop parts on the surface of the diseased area. An example would be the rust fungi.

Mushrooms, molds, and mildews are common fungi.

Bacteria are some of the smallest living organisms on earth. As many as 25,000 individual bacteria can be laid side-by-side in a one-inch space.

Reproduction of bacteria can be very rapid under certain conditions. A bacteria reproduces by simply dividing into two parts, each of which is a complete living plant. This may happen as often as every hour, so that within one day, if all survived, there would be seventeen million bacteria resulting from one dividing bacteria.

Bacteria produce some of the most destructive plant diseases.

Weeds are not often called plant pests, but through competition they often cause problems in growing desirable plants.

A weed can be defined as any plant growing where it is not wanted. Sometimes, plants usually considered desirable could actually be called weeds. An example would be a corn plant growing in a row of tomatoes.

For purposes of control, weeds are classified as either grasses or broad-leaved. Specific identification is usually necessary for adequate control. It is suggested that the teacher develop a list of common local weeds of both types and use samples of these for teaching purposes.

Weeds can also be classified according to their length of life. These classifications are annual, biennial, and perennial.

Annuals are plants which live but one season. They can be placed into two groups. Summer annual seeds sprout in the spring. The plants grow and produce a new crop of seeds before they are killed by frost. The seeds lie dormant through the winter. Winter annual seeds sprout in the fall or winter, grow, and produce seeds in the spring or early summer before dying. The seeds lie dormant until fall.

Biennials are plants which live but two years. The first year they usually develop roots, leaves, and stems but no flowers. They become dormant over the first winter. The second season they develop flowers and seeds and die.

Perennials are plants which live more than two years. They may further be broken down into two classifications. Simple perennials spread only by seed; however, if the stem or root is cut, the pieces may produce new plants. Creeping perennials reproduce by creeping roots, creeping above-ground stems, or below-ground stems as well as by seed. Creeping perennials are probably the most difficult group of weeds to control.

Scientists differ as to whether viruses are living organisms or not. They do agree that viruses cause a number of serious plant diseases. Viruses can infect a plant only through injured tissue. They are often carried from plant to plant by workers, insects, or other animals.

Insects are the most common type of animal life on earth. Many insects are helpful to man; however, there are some insects which cause damage to desirable plants. Insects cause most plant damage through their feeding habits. It is necessary to classify them according to the type of feeding they do for chemical control purposes. The two basic types of feeding by harmful insects are by chewing, and by piercing the tissue to suck out plant juices.

Some harmful insects can be controlled only at certain times of the year. For various reasons, some insects live in parts of the plant or environment protected from most control measures. Therefore, it is necessary to learn the life cycles of the insects we study in order to learn when they can be most easily controlled.

The development of certain insects proceeds in a series of steps from an egg to an adult. In all stages beyond that of the egg, the physical appearance is similar. The grasshopper is an example of this type of insect development.

Other insects undergo a complex series of changes beginning with the egg which hatches into a larvae. This larvae, or "worm," as it is often called, usually is the stage at which the insect causes the most damage to plants. The larvae then changes into a pupa, or resting state. After a time, the pupa changes into an adult form of the insect.

There are a number of small animals. Often, some of them which cause plant damage are mistakenly called insects. These include the mites, sowbugs, pillbugs, millipedes, nematodes, slugs, and snails. Nematodes are tiny round worms usually too small to be seen with the naked eye. They most often affect the roots of plants by feeding on them.

Occasionally, plant damage results from the action of some larger animals. Moles often damage plant roots by burrowing under the surface soil in search of grubs upon which they feed. Mice, rabbits, deer, and other mammals also cause considerable plant damage.

Some factors of the environment may also cause plant damage. The following is a list of some environmental factors responsible for plant damage:

1. Low temperature
2. High temperature
3. Rapid temperature changes
4. Abnormal light conditions
5. Soil moisture variance
6. Atmospheric pollution
7. Lightning injury
8. Deficiency or excess of minerals
9. Root growth girdling roots on trees.

Suggested Teaching-Learning Activities

1. Ask the students to recall the classification of pests of human beings discussed during the introduction of this module. Discussion should bring out the fact that plant pests can be classified in a similar way. Place on the blackboard and refer to the list, "Kinds of Plant Pests," listed under subject matter content of this competency.

2. Point out some common fungi and how they affect some of our common plants. The following examples are familiar to the students and are usually readily available:

   bread mold, mushrooms and toadstools, citrus green mold.

3. Certain characteristics of bacteria and their affects on plants can be illustrated as follows: Bruise a portion of a head of lettuce, keep moistened and in contact with soil at near room temperature. Bacterial soft rot should develop within several days. Have students transfer a small portion of the diseased tissue to a fresh head of lettuce. Keep moist and in a temperature as close to 85° as can be maintained. Make observations at least once per day to note when decay begins to develop on the fresh lettuce head.

   Point out that bacteria are some of the smallest pests of plants. If 25,000 individual bacteria would be laid side-by-side, they would fit within the space of one inch. By comparison, if 25,000 high school students were placed shoulder-to-shoulder, the line would cover over seven miles.

4. The teacher should develop a list of weeds common to the geographical area in which the course is offered. Mounted specimens and potted weeds should be readily available at all times for student observation and study. Mounted specimens can be arranged in an attractive bulletin board display. Potted weeds may be grown in the greenhouse, hotbed, or on the classroom windowsill. (Note: Pot up only weed seedlings. Mature plants, particularly of perennial weeds, rarely can be successfully transplanted into pots.) Plants and specimens should be readily accessible to all students.

5. Students should make personal connections of local weed specimens and suitably mount them for reference. In addition to providing student reference material, this activity will cause students to become more familiar with the plant characteristics.

6. Have students study mounted insects common to the area. These can be learned most easily by grouping them according to the plants they infest. Categorization could be made of: insect pests of vegetable crops, insect pests of trees, insect pests of shrubs, insect pests of flowers, and insect pests of fruit crops.

7. Assign students to develop an insect collection which should be carefully identified. This collection might be a collection of insects affecting ornamental plants.

8. Bring in and cage up with its food supply a larvae of some common local insect pest. Observe and record the growth and change in physical appearance of the insect as it passes from one stage to another. The cabbage butterfly larvae would be an example.

9. Bring in pictures of mice, moles, rabbits, deer, or other local animals which damage plants. If any plant damaged by these animals is available, bring this in for observation and discussion.

10. To illustrate some of the adverse effects of certain environmental conditions on plants, have students plant bean seeds in paper cups or other containers. Three seeds should be planted per container in case poor germination occurs. This should be done at least one week in advance of the need for the plants. A standard potting soil mix should be used for all but two pots. These two should be planted in sand. At least ten containers should be planted. When seedlings are from four to six inches tall, students should place the pots in the following environmental situations. Daily written records should be kept by each student of the condition of each plant.

    a. Place one pot in a low temperature situation. This could be in a refrigerator or an insulated chest with ice.

    b. Place one pot in a high temperature situation. This could be an unventilated cage made of panes of glass placed in the greenhouse or near a classroom window.

c. Place one pot in a dark situation. This could be under an inverted cardboard box.

d. Place one pot in a wet situation. This can be done by standing the pot in a saucer which is kept full of water.

e. Place one pot in a dry situation. Do not water the plant.

f. One plant should be placed where it can be affected by atmospheric impurities.

g. One pot with seeds planted in sand should be fertilized with a small handful of a common chemical fertilizer to illustrate over-fertilization effects.

h. One pot with seeds planted in sand should not be fertilized, to illustrate the lack of fertilization effects.

11. Continue observation of the plants on the school grounds. After symptoms have been described, continue with identification of the pest causing the problem. Point out the importance of using references for accurate identification.

12. Have students bring in plants affected by pests. Students should describe the symptoms and identify the pest as accurately as possible using reference materials. State extension bulletins are suggested, since they provide pertinent information and are inexpensive for student use. The teacher should have available the suggested reference books for pests which cannot be identified from extension bulletins.

13. Student evaluation should be done by having students identify pests on sample plants brought in by the teacher, or from mounted pest specimens.

Suggested Instructional Materials and References

Instructional Materials

1. Samples of bread mold, mushrooms, or citrus green mold.

2. Two heads of lettuce

3. Mounted weed specimens

4. Potted weed specimens (Potting should be done with weed seedlings, since mature plants rarely can be transplanted successfully into pots. Potting should be done several weeks before the need for the plants to allow them to assume mature plant characteristics.)

5. Mounting paper for student weed mounts

6. Labeled insect connection. This could be obtained by the teacher or through a student project.

7. Insect pins and killing jars

8. Screen cages for insects. Simple cages can be obtained by the teacher or through a student project. These cages can be student-constructed by "sewing on" with string circular screen and pieces on a tube of fine mesh screening.

9. Containers, soil, sand, bean seeds, five panes of glass, any common chemical fertilizer, ice chest and ice (or access to refrigerator)

References

1. Muenscher, W. C. Weeds.

2. Pirone, Dodge, and Rickett. Diseases and Pests of Ornamental Plants, p.p. 69-98.

3. Controlling Insects on Flowers, Bulletin No. 237,

4. Handbook on Insect Enemies of Flowers and Shrubs, Miscellaneous Publication No. 626, U. S. D. A.

5. State extension bulletins covering pests in the geographical area where course is being taught. Insects and Diseases of Vegetables in the Home Garden, Bulletin No. 46, U. S. D. A.

6. Insects: The Yearbook of Agriculture, 1952. U. S. D. A.

7. Different state extension bulletins on local pest control.

Suggested time to develop the competency

Classroom teaching	5	hours
School laboratory activity	15	hours
Total time	20	hours

IV. To develop the ability to use proper control measures for pests affecting horticultural plants

Teacher Preparation

Subject Matter Content

Pests of horticultural plants can be controlled in three basic ways. These are:

1. Exclusion
2. Eradication
3. Protection

Exclusion of plant pests is an attempt to keep specific pests out of the geographical area concerned. This involves inspection and quarantine measures at the borders of our country, by states, and at specially designed zones within states.

It is against the law for you to bring through customs any plant materials unless they are inspected and declared free of plant pests. Before these laws were introduced, a number of pests became established in the country and caused millions of dollars worth of damage. Examples are the Mediterranean Scale and the Japanese Beetle.

It is against the law to carry certain plant materials across state borders. Some states, particularly in western U. S., have inspection points along the highways for the purpose of checking for undesirable pests which may bring in economic ruin.

Certain areas of a state or the country are designated as "quarantined" when a very damaging plant pest becomes established. It is against the law to carry plants which could have

the pest out of the quarantined area.

Why all the concern about introducing plant pests? Plant pests native to an area generally have natural enemies which help keep them under control. Upon introduction into a new area, the pest will increase in numbers because its natural enemies are not present. Referring again to the "balance of nature," we can show the imbalance created by introducing a new pest as disastrous to the plant upon which it feeds.

An example of this devastating effect can be made by reviewing the history of the Chestnut Blight. It was first noticed in New York City in 1904. Within several decades it killed almost all of the American and European chestnuts grown in the United States. The pest was traced to the Orient, where, it is not a serious threat.

It is now evident that exclusion is an important part of plant pest control.

Eradication is an attempt at complete elimination of a present pest. Either the pest itself, or the plants upon which it feeds, are eliminated.

One method of eradication practiced is that of crop rotation. In the process of rotating crops from field to field over a period of years, any pest overwintering in the soil dies when the crop upon which it feeds is not grown at that location. It should be pointed out that the method is effective only with pests that overwinter in the soil and live for no more than two or three years without the plant upon which it feeds.

Sanitation, or clean-up of pest-damaged plants in which the pest remains, or removal of trash such as infested fallen leaves or weeds is another method of pest eradication. This method is only effective if the pest remains in or on the plant. Some plant pests overwinter on wild perennial plants. Pest eradication can be accomplished by eliminating the wild perennial plant. The pest dies without means for winter survival.

We probably will always have some pests. It may be impossible or unwise to completely eradicate certain pests. Therefore, it is necessary to protect the desirable plants that we grow, and minimize the damage to them.

One method of protecting the plants we grow is through the development of pest-resistant varieties. A number of pest-resistant horticultural crop varieties, mostly vegetables, have been

developed. Horticultural service employees generally are not involved directly in the development of resistant varieties, but it should be advised to make use of them whenever possible.

A number of our plant problems result from environmental conditions. Plants generally require specific environmental conditions for best growth. Rhododendrons, for example, require an acid, organic soil which some other plants could not grow well in. Chrysanthemums grow best under cool temperatures, while portulaca does not. Poinsettias bloom only during periods of short days, while petunias are not so critically affected.

According to the needs of the plant, the correct manipulation or control of the following factors will reduce problems due to the environment:

1. Air
2. Light
3. Minerals
4. Temperature
5. Water

The use of chemicals for the control of plant pests began to develop in about 1885 when Bordeaux mixture was used in France to control Downy Mildew. Since the Second World War, the development and use of chemicals for pest control has increased tremendously.

Chemicals used for pest control are called "pesticides." The suffix "cide" means "killer." Chemicals which kill fungi are called "fungicides". We also have herbicides (herb or plant killers), insecticides (insect killers), miticides (mite killers), moluscicides (snail and slug killers), nematocides (nematode killers), and rodenticides (rodent killers).

All chemicals used as pesticides can be poisonous to other living things, if not properly used. Great care must be given to storage, handling, and application of pesticides.

The application of pesticides is usually done as a preventative measure. Specific application programs are developed by each state for most plants grown in the area. Pesticides are usually applied before the pest problem develops to reduce the damaging effects of the pest.

Many chemicals used as sprays will not stick to the plant surface or spread out to provide complete coverage. It is necessary to add some material to cause the pesticide to form a film over the sprayed part and to stick to the surface. These materials are called spreader-stickers and are commercially available. Use can be made of common household detergents or other materials.

Since pesticides and recommendations for their use are constantly being revised, no recommendations will be given in this module. Refer to local state extension bulletins for current recommendations.

The control of weeds in horticultural plantings often becomes the biggest job of horticultural employees. A weed problem can develop in ornamental plantings as well as in crops.

It becomes important to determine the weed control situation before it becomes severe enough to require an uneconomical approach.

In planning ornamental plantings, effort should be made to use plant materials which can meet or outgrow most weed competition. Many ground cover plants develop and grow vigorously enough to crowd out most annual and some biennial and perennial weeds. Some shrubs are dense, and cast enough shade to reduce any weed growth underneath.

Mulches may provide a degree of weed control in certain situations. A satisfactory weed-controlling mulch would be any material placed on the surface of the soil. If it were composed of plant remains and were placed thickly enough, it would smother most annual weeds. Organic mulches, applied properly, cannot often control perennial weeds, since these weeds contain enough food reserve to allow extensive top growth which could grow a mulch material. Polyenthylene or treated paper sheets are more effective mulches for the control of perennial weeds, since they prevent weeds from growing through. In some areas stone or pebble mulches are used, particularly in ornamental plantings.

If organic or stone mulches are used, it is important that they be placed thickly enough to minimize weed penetration. Usually the coarser the mulch material, the thicker it must be placed.

It is likely that all students have had experience in "pulling weeds." This method still has application in certain horticultural jobs. In many situations, hand weeding, hoeing, or machine cultivation is preferred over chemical control.

Hoeing and hand cultivating are best done as one moves forward as he works. Many beginners attempt to move backward to avoid leaving footprints. In doing this, however, the soil or weeds are not evenly loosened.

Hand weeding involves some skills not inherent in beginning horticultural employees. The weeds should be grasped near the soil line with one hand and pulled sideways away from the desired plant. At the same time, the other hand should grasp the desired plant at the soil line and hold it in place so it is not unintentionally pulled out with the weed.

Wheel hoes and power cultivators are designed to either cut off the weeds at or just below the surface of the soil, or to cover the weeds with soil. Loosening the surface layer of soil causes it to dry out, which in turn reduces new weed seed-germination.

Mowing is a form of mechanical weed control. If properly done, it prevents the flowering and seed formation of weeds. In some cases, repeated mowing of foliage causes a reduction of food making by the plant resulting in a poorer plant.

The important factor in hand of mechanical weed control is to begin while the weeds are germinating or under several inches in height.

Since World War II, chemical weed control has developed rapidly in the horticultural industry. Three basic types of herbicides (chemical weed-killers) are used. Each type affects plants in a different manner. These are: contact, growth-regulating, and soil sterilants.

Contact herbicides have also been developed as selective or non-selective. Selective herbicides will kill some plants, but not others; while non-selective herbicides kill all plant growth upon which it is applied.

Growth-regulators are called systemic herbicides because they are carried throughout the plant. If applied in the correct amount to the foliage, the herbicide will travel throughout the entire plant, killing all cells. The death of the plant may not occur immediately, since movement of the herbicide in killing quantities may require several weeks. Furthermore, growth regulators are somewhat selective in that they only affect some plants.

Soil sterilants are herbicides applied to the soil which prevent all plant growth. Some are effective only for days, others for years. They are effectively used in situations such as unpaved

drives, walks, or along railroad tracks.

The value of an herbicide is also determined by when it can be effectively used. Some herbicides can be applied to seed beds before planting and kill most weed seeds (and some plant diseases). This is called pre-planting treatment.

Most herbicides, however, are classified in two categories: pre-emergence and post-emergence.

A pre-emergence type herbicide means that it can be applied after seeding a crop, but before it, or weed seeds, germinate.

A post-emergence type herbicide can be applied after the specific crop or weeds have germinated.

The horticultural employee must know where and how herbicides should be applied. Some herbicides are broadcast evenly over an area. This would often be done in the application of herbicides on lawns.

Some herbicides are applied in a narrow strip on row crops. The treated strip is directly over the row of desired plants. The cost of using herbicides is reduced, since they are only applied in narrow strips. The area between rows may be mechanically cultivated. Thus treatment is commonly referred to as band treatment.

Some desirable plants cannot continue to live with the herbicides which must be used to control the surrounding weeds. In this case the herbicide application must be directed at the weed zone and prevented from reaching the desirable plants or foliage of these plants.

Spot treatment is occasionally necessary. Herbicides are applied only to the weed plants themselves and not to the surrounding area.

The application of herbicides can, in summary, be made in the following ways:

1. Broadcast treatment
2. Band treatment
3. Directed sprays
4. Spot treatment

Insects can cause plant problems through their feeding habits or by introducing fungi, bacteria, or viruses which in turn cause plant problems.

Protection of plants from insect damage is a big part of pest control. One method used is fumigation of soil or plants which often contain insects in various stages of growth. A poisonous gas is introduced into a closed area containing the soil or plants. Exposure to the poisonous gas kills the insect. This method is used on many shipments of plants arriving from outside the borders of the United States.

Barriers of some screening material are often used to protect plants from insect pests. For example, in some parts of the country, asters grown commercially must be grown in screen or cheesecloth houses to protect them from the virus causing the disease "aster yellows." The virus is transmitted by a leafhopper which must be kept away from the aster plants.

Chemical control of insects is probably the most efficient control measure for horticultural plants. Many insecticides are available to the professional horticulturist; however, some are extremely dangerous and must be applied only while wearing specified protective clothing. Other insecticides are not dangerous if applied according to directions. It must be kept in mind that all insecticides are dangerous if not properly used, or if left where they can be reached by children or pets.

Since insects feed on plants in basically two ways, (chewing or piercing-sucking), two basic types of insecticides have been developed.

Stomach poisons were developed for the control of chewing insects and are applied to the surface of the plants. When chewing insects begin feeding on the coated foliage, they eat some of the insecticide and die.

Piercing-sucking insects generally do not eat enough of the surfact layer of plants to be affected by stomach poisons. For this reason, insecticides called contact poisons are used. These poisons kill by suffocating and paralyzing insects and other animals.

Systemic insecticides have been developed within recent years. These are chemicals which can be absorbed by the plant in large enough quantities to kill any insects feeding upon them. They are used extensively on ornamental plants. Food crops should not be grown on soils treated with systemic insecticides.

Since pesticides and recommendations for their use are constantly being revised, no recommendations are given in this module.

Refer to extension bulletins for current recommendations for your state.

Control of desirable plants against attacks of fungi, bacteria, and viruses, as with other pests, is best approached from the standpoint of prevention. Exclusion of certain of these pests from our growing areas and eradication of other pests have contributed considerably to pest control efforts. Nonetheless, certain fungi, bacteria, and viruses will likely be present and could cause some problems. For this reason, protective application of chemicals is often recommended.

Most fungicides available are protective in nature. They must be present on the surface of the plant before the fungus infects. Most fungi, powdery mildew excepted, cannot be killed once they have developed within the plant, so protective control measures call for regular spraying or dusting. To be effective, the fungicides must be applied regardless of possibilities of infection.

Bacteria are more difficult to control than fungi. Copper containing materials (such as fungicide) are used on a protective basis to aid in the control of bacterial diseases. Currently, certain antibiotics are also being used to help combat the plant diseases brought about by bacterial invasion. Streptomycin and terramycin are the two commercially available antibiotics recommended for horticultural use. Consult state extension bulletins for recommended procedures for using these materials.

No effective chemical control for viruses affecting plants is commercially available. Present control methods involve preventing transmission of the virus. This may involve using chemical sprays following a strict sanitation program, and preventing mechanical transmission.

Specific recommendations for the use of protective chemical controls should be obtained from current state extension publications. All chemical pesticides must be applied as directed. Exact amounts often must be used for effectiveness and safety. Under no circumstances should any change be made from the official recommendations.

Since the application of chemical pesticides requires a high degree of accuracy, it is important that only good equipment be used.

Chemical pesticides are applied either in liquid form as a spray, or in dry from as a dust. Application equipment is basically of two types: sprayers and dusters. Many forms of each are available.

Sprayers are probably used more often than dusters by commercial horticulturists. Uses can be found for sprayers of all types and sizes, since situations where they are used vary so greatly.

Hand sprayers of various designs have use when the plants to be sprayed are small or require spot treatment. They are relatively inexpensive, but effective. The continuous pressure kind with adjustable nozzle is recommended.

Compressed air sprayers have a capacity of from one to five gallons. Pressure is built up by a small hand pump, which makes an economical, versatile sprayer.

Knapsack sprayers are designed to be carried on the back. Pressure for spraying is maintained by pumping a handle. Capacity is from two to six gallons.

Trombone or slide-action sprayers are inexpensive and quite reliable. A continuous spray is emitted by sliding the handle forward and back much in the manner of a trombone.

Wheelbarrow sprayers are quite varied in design and have capacities up to fifty gallons. Less human fatigue develops if two people operate the sprayer; one to spray and one to operate the pump.

Garden hose sprayers are attached to a garden hose which provides the pressure. The spray concentrate is diluted and mixed with the passing water. Where extreme accuracy in rate of application is needed, compressed air or pump sprayers are recommended.

Power sprayers vary greatly in design and capacity. They may be powered by either an electric motor or gasoline engine. They are economical only where extensive spraying is done.

All types of sprayers should be rinsed with clean water after use. Sprayers for weed killers should be cleaned according to specifications. It might be more economical to have separate sprayers for herbicides, and one for other uses, especially when hormone type herbicides are used. Seasonal maintenance procedures call for careful cleaning of the tank, as well as dismantling and thoroughly cleaning all nozzles, filter screens and accessories.

Dusters are available in a number of designs. In general, they are more simple in construction than sprayers.

Plunger-type dusters are made from a number of materials, including cardboard. The best construction to date has been of metal. Fairly good coverage can be obtained with plunger-type dusters used on small jobs.

Bellows and rotary fan dusters provide a somewhat larger capacity than the plunger-type and give somewhat better coverage. The small hand-models of up to five pounds capacity have limited use, due to limited capacity. The larger models with up to twenty-five pounds capacity have greater commercial usage value. These are often carried in front by shoulder-straps and operated by a lever or crank.

Mist-blowers are one of the newest innovations for applying pesticides. These can be termed portable power sprayers or dusters which can be carried on the back. Blasts of air are used to propel the pesticide with effective coverage.

Accuracy is most important in successful pest control.

Accuracy is important in:

1. Determining the pest problem
2. Determining control measures
3. Mixing materials if chemicals are used.
4. Timing the application
5. Making the application

It is evident, then, that one aspect of the need for accuracy is in the measurement of the pesticides to be used. In order to accomplish this, the following equipment is required:

1. A set of standard measuring spoons
2. A "letter balance" for weighing small quantities in ounces.
3. A larger scale for weighing materials in pounds
4. A set of standard liquid measure containers: ½ pint, 1 pint, 1 quart, 1 gallon

This equipment should be kept specifically for the purpose of measuring quantities of pesticides and be readily available at

all times. Do not use these utensils for food-handling or place them where they can mistakenly be taken and used in connection with human or other animal food-handling.

Suggested Teaching-Learning Activities

1. Point out to the students that we attempt to control pests in three ways:

   a. By attempting to keep them out of a country or a part of a country (Discuss plant quarantines and inspection.)

   b. By killing all pests which are found in an area (Discuss sanitation, crop ratation, fumigation.)

   c. By protecting the desirable plants. (Discuss regulation of environment, cultural practices, handling practices, control insects, using sprays and dusts.)

2. Bring in sample plants requiring quite different environmental conditions. Discuss these plants and the importance of environmental factors in controlling plant problems. Emphasize the varying needs of plants in relation to the following factors: air, light, minerals, temperature, and water.

3. Assign students to review seed catalogues and list the various pest-resistant horticultural plants available. Categorize them into groups such as root crops, leaf crops and annual flowers.

4. Assign interested students to bring in labels from empty pesticide containers (do not bring in containers, since some may contain toxic residue) or manufacturer's literature. These can be arranged for display purposes and to help keep the names of the products readily available for student use.

5. To illustrate the translocation of herbicides as discussed in Paragraph 8 on Page 23, place a small amount of 2, 4-D on a tomato leaf and cover the treated leaf with a plastic or cellophane wrap. In time, the entire plant will be affected.

6. Arrange for a tour of a garden supply outlet which handles pesticides. Have a competent representative explain the uses of the various available materials and why the number of different kinds are stocked by the concern.

7. Observe several examples of ground cover plantings. These may be found in several places in the neighborhood. Have students discuss why some plantings have few or no weeds, while others may have a serious weed problem.

8. Have students identify and assess a weed problem on the school grounds or nearby. This may be lawn or ornamental plantings, or crops. Each student should prepare a report including identification of weeds present and recommend an appropriate herbicide application. If circumstances permit, have students apply the correct herbicide and keep records of the resultant weed reaction.

9. Bring in, identify, and discuss sample mulch materials for local area use.

10. Have each student develop a satisfactory level of skill in hand weeding, cultivating, hoeing, and using other available tillage machinery.

11. Demonstrate the proper calculation of amounts needed, mixing, and application of several pesticides. Revisit the treated areas regularly to note and discuss the effects of the pesticide applications.

12. Assign students practical problems in calculation of square footage of areas to be treated with pesticide.. Problem areas should be practical and include areas irregular in shape. This practice-calculation could be done on various areas of the school grounds.

13. Assign students problems in converting amounts of spray materials recommended for certain quantities of water (example: two gallons). Use tables provided in this module.

14. Continue school grounds inspection begun earlier. If situation warrants, plan and carry out a pest control program with plants on the school grounds.

15. Bring in samples of various dusters, sprayers, and mist blowers, and have students identify them and practice using them loaded. Sprayers would be used with clean water, dusters with flour. Emphasize safety in handling. Require all students to practice spraying and dusting with each available piece of equipment. All equipment should be treated as if loaded with toxic

materials. Require students to clean equipment at end of session.

16. Evaluate each student throughout his work on his competency to arrive at an estimate of his skill in handling practical field problems.

Suggested Instructional Materials and References

Instructional Materials

1. Sample plants which require different environmental conditions
2. Labels from various pesticides (can be obtained with student help) or manufacturers' literature
3. Locate several ground cover plantings for observation
4. Locate weed-infested area
5. Mulch materials
6. Several hoes, cultivators. If available, push hoe or cultivator, garden tractors with cultivators and other tillage implements
7. Samples of sprayers, dusters
8. Flour or other non-toxic material for practice-dusting
9. Duplicate enclosed information sheet

References

1. Muenscher, W. C. Weeds: pp. 48-62.
2. Pirone, Dodge, and Ricket. Diseases and Pests of Ornamental Plants: pp. 99-127.
3. Sharvelle, E. G. The Nature and Use of Modern Fungicides.
4. Shurtleff, M. C. How to Control Plant Diseases, 1962.
5. Insects: The Yearbook of Agriculture.

S 6. Various state extension publications on pest control recommendations.

Suggested time to develop the competency

Classroom teaching	5	hours
School laboratory activity	28	hours
Total time	33	hours

Suggested Occupational Experiences

1. Employment in a garden store as a salesperson, if the student is capable of saleswork. This would bring the student into close contact with pest problems. The student should:

   a. Learn as many pesticides as possible

   b. Be able to prescribe a suitable pesticide for common local pests. There will undoubtedly be many occasions where the student will not be able to make a positive recommendation as to the pesticide to be used in a particular situation. If this should happen, the customer should be referred to someone having more knowledge of the problem area, rather than being sold a material just for the sake of making a sale.

2. Employment by a landscaper or on a grounds maintenance crew in a park system. The student should refine and further develop skills for the safe application of pesticides.

_____ High School

Department of Vocational Agriculture

Measurement of Spray Materials

Very careful attention must be given to the job of measuring out the spray chemicals. One mistake on your part could cause injury to you, someone else, or other animals and plants.

General Information

100 gallons of water= 833 pounds. 1 gallon water= 8 1/3 pounds.
1 gallon= 8 pints= 128 fluid ounces; 256 tablespoons= 768 teaspoons.
1 pint= 2 level cups= 16 fluid ounces= 32 tablespoons= 96 teaspoons.
1 cup= 8 fluid ounces= 16 tablespoons = 48 teaspoons.
1 tablespoon= 3 teaspoons. 1 fluid ounce= 2 tablespoons=6 teaspoons.

Mixing Small Amounts of Spray Material

No exact figure for small sprayer usage can be given because spray chemicals vary in bulk per unit weight. However, a rule of thumb is:

2 pounds of wettable powder per 100 gallons is approximately equal to 1½ level teaspoons per gallon. (This is based on 50% DDT Wettable Powder. Wettable powders vary as to density.) 1 pint of liquid per 100 gallons is equal to approximately one level teaspoon per gallon.
3 pints (1½ quarts) per 100 gallons is equivalent to one level tablespoon per gallon.

43,560 sq. feet = 1 acre. 1,000 sq. feet = 1/43 acre.
100 sq. feet = 1/435 acre.

Calculations for Volume, Area, and Mixing Pesticides

1 bushel = 1.24 cu. ft. or .05 cu. yards

1 cu. ft. = .037 cu. yd. or .804 bu. or 1,728 cu. in.

1 cu. yd. = 27 cu. ft. or 21.70 bu. or 46,656 cu. in.

1 gal. water = 231 cu. in. or .13 cu. ft. or 8.34 lbs.

1 cu. ft. water = 7.5 gallons or 62½ lbs.

1 acre = 43,560 sq. ft.

1 acre of soil 6 2/3 inches deep = 2,000,000 lbs. when dry.

Mist Blowers

Highly concentrated materials can be used in mist blowers because the insecticide is applied in a fine mist that dries quickly. Liquid concentrates should be used because wettable powders may clog nozzles when used at high concentrations. Some liquid concentrates can be used safely at higher concentrations, but as a general rule a 25-X concentration should be the maximum. A 25-X concentration is one that is 25 times that normally used in a hydraulic sprayer (the quantity of the insecticide used per gallon of water in the hydraulic sprayer). Also the area sprayed with one gallon by the mist blower equals the area sprayed with 25 gallons with an hydraulic sprayer.

Quantity of Liquid Concentrate Needed to Make a 25-X Concentration

Hydraulic	Mist Blower			
100 Gallons	25 gallons	10 gallons	2 gallons	1 gallon
1 pint	6¼ pints	2½ pints	8 fl. oz.	4 fl. oz.
1 quart	6¼ quarts	5 pints	1 pint	8 fl. oz.
2 quarts	3.1 gallons	5 quarts	1 quart	1 pint
1 gallon	6¼ gallons	2½ gallons	2 quarts	1 quart

Pesticide Dilution Table

The quantity of wettable powder used in small hydraulic sprayers when the quantity per 100 gallons is known.

100 gallons	10 gallons	5 gallons	2 gallons
1 lb.	1.6 oz.	.8 oz.	.3 oz.
2 lbs.	3.2 oz.	1.6 oz.	.6 oz.
3 lbs.	4.8 oz.	2.4 oz.	1.0 oz.
4 lbs.	6.4 oz.	3.2 oz.	1¼ oz.
5 lbs.	8.0 oz.	4.0 oz.	1.6 oz.

The quantity of liquid concentrate used in small hydraulic sprayers when the quantity per 100 gallons is known.

100 gallons	10 gallons	5 gallons	2 gallons
1 pint	3 tablespoons	2 tablespoons	2 teaspoons
1 quart	3 fl. oz.	3 tablespoons	1 tablespoon
2 quarts	6.4 fl. oz.	3.2 fl. oz.	1.3 fl. oz.
1 gallon	12.8 fl. oz.	6.4 fl. oz.	2.6 fl. oz.

Dilution Table for Contact Sprays

Amount of Finished Spray	Amount of Spray Material to use for Dilution 1-200	1-400	1-600	1-800
1 quart	1 tsp.	½ tsp.	1/3 tsp.	¼ tsp.
1 gallon	4 tsps.	2 tsps.	1½ tsp.	1 tsp.
5 gallons	3 1/5 oz.	1 3/5 oz.	1 1/5 oz.	4/5 oz.
50 gallons	1 quart	1 pint	12 ounces	8 ounces

Suggestions for Evaluating Educational Outcomes of the Module

This module has been concerned with the various skills and abilities necessary to recognize and control plant pests. As a result of the knowledge gained in this module, the students should be able to perform the tasks listed below with a minimum of additional instruction by the employers.

1. Recognize symptoms of some common plant disorders and pests.
2. Safely apply prescribed plant pest control measures.
3. Maintain spraying and dusting equipment.

The following check list can be used by the teacher to determine whether or not the student can perform the above tasks:

1. Does the student understand the need for pest control?
2. Does the student know how plant pests affect us?
3. Does the student realize the effect environment has on plants?
4. Does the student understand the relationship between the various pest and their host plants?
5. Can the student recognize pest symptoms, and if possible, the pest itself, to offer an accurate identification of a significant number of common local plant pests?
6. Can the student identify and operate common pesticide applicators?
7. Can the student properly follow directions and mix a specific quantity of any chemical pesticide studied?
8. Does the student understand the proper storage methods of dangerous pesticides?
9. Does the student use known safety precautions in handling and applying pesticides?

Spot-check student attitudes toward doing the job. All people do not enjoy doing all jobs; but all jobs must be done. Often an individual is assigned to a job he dislikes. Display of a proper attitude at that time deserves commendation. It is important that these students develop positive attitudes as well as skills.

Constantly spot-check knowledge-retention throughout discussion techniques concerning various observed plant pest problems.

Sources of Suggested Instructional Materials and References

1. Janick, J. Horticultural Science, San Francisco: W. H. Freeman and Company, 1963.

2. Muensher, W. C. Weeds, second edition, New York: The MacMillan Co., 1962.

3. Pirone, Dodge, and Ricket. Diseases and Pests of Ornamental Plants, third edition, New York: Ronald Press Co., 1960. Price: $12.

4. Rohm and Haas Company. Compendium of Plant Diseases, Chicago, Illinois: The Lakeside Press; R. R. Donnelly and Sons Company, 1959.

5. Sharvelle, E. G. The Nature and Use of Modern Fungicides.

6. Shurtleff, M. C. How to Control Plant Diseases, Ames, Iowa: The Iowa State University Press, 1962.

7. Agricultural Chemicals, 1963. Manufacturing Chemists' Association, Inc. 1825 Connecticut Ave. N. W., Washington 9, D. C.

8. Insects: The Yearbook of Agriculture. Washington 25, D. C.: The U. S. Government Printing Office, 1952.

9. Plant Diseases: The Yearbook of Agriculture. Washington 25, D. C.: The U. S. Government Printing Office, 1953.

10. State Extension Service circulars on specific pests of plants. Many excellent bulletins available. Write to State Extension Service in your state.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
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INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
   _____Ornamental Horticulture--Service Occupations
   _____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
   _____

6. How many students:
   a) Were enrolled in class (total) _____
   b) Participated in studying this module _____
   c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

_____ _____
(Date) (Instructor's Signature)

_____
(School Address)